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Reduced global warming from CMIP6 projections when weighting models by performance and independence

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To extract reliable estimates of future warming and related uncertainties from multi model ensembles such as CMIP6, the spread in their projections is often translated into probabilistic estimates such as the mean and likely range. Here, we use a model weighting approach, which accounts for the CMIP6 models' historical performance as well as their interdependence, to calculate constrained distributions of global mean temperature change.

We investigate the skill of our approach in a perfect model test framework, where we use previous-generation CMIP5 models as pseudo-observations in the historical period. The performance of the distribution weighted in the abovementioned manner with respect to matching the pseudo-observations in the future is then evaluated, and we find a mean increase in skill of about 17 % compared with the unweighted distribution. In addition, we show that our independence metric correctly clusters models known to be similar based on a CMIP6 “family tree”, which enables the application of a weighting based on the degree of inter-model dependence.

We then apply the weighting approach, based on two observational estimates, to constrain CMIP6 projections. Our results show a reduction in the projected mean warmingbecause some CMIP6 models with high future warming receive systematically lower performance weights. The mean of end-of-century warming (2081–2100 relative to 1995–2014) for SSP5-8.5 with weighting is 3.7°C, compared with 4.1°C without weighting; the likely (66%) uncertainty range is 3.1 to 4.6°C, which equates to a 13 % decrease in spread.